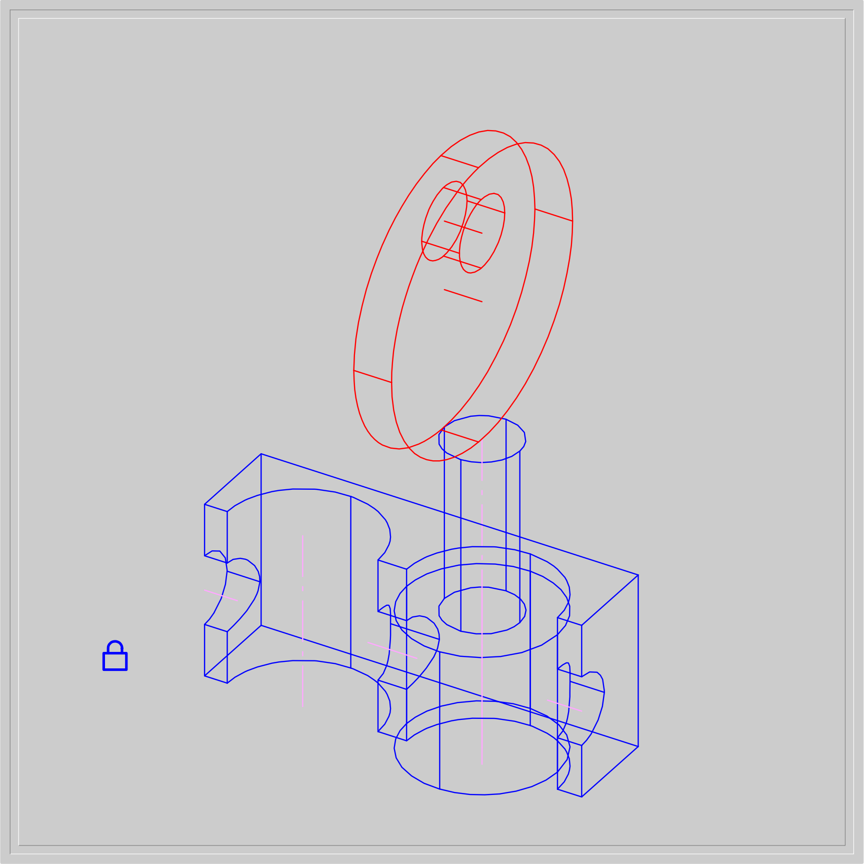


Creating a Mechanism

I-DEAS Tutorials: Fundamental Skills

Learn how to:

- define rigid bodies
- ground rigid bodies
- create joints
- define motions
- solve motions
- display results

Before you begin...

Prerequisite tutorials:

1. Getting Started (I-DEAS™ Multimedia Training)

–or–

Quick Tips to Using I-DEAS
–and–
Creating Parts

2. Managing Parts in Model Files

3. Using Libraries

4. Creating Assemblies

If you didn’t start I-DEAS with a new (empty) model file, open a new one now and give it a unique name.

File
Open

Open Model File form

Model File name: any unique name
OK

Make sure you’re in the following application and task:

Design or Simulation
Assembly

Set your units to mm.

Options
Units

mm (*milli newton*)

Start by getting the assembly you built in the Creating Assemblies tutorial.

Get from Project Library form

Assembly Workshops...(double-click)

Valve Assembly

Copy

OK

The Valve Assembly and all parts have been copied to your bin, but are not yet visible on the workbench.

Warning!
In this tutorial you're making a **copy** of the assembly. Copies of parts and instances are no longer associated with the original design.

You should normally use check-out or reference instead of a copy. A copy is used in this case to teach the objectives of this tutorial without changing the contents of the library, which will be used for other tutorials.

At the end of the tutorial you'll delete the copy of the assembly and **not** check it back into the library.

Although the Valve Assembly was copied, all of its children were brought into your model file as a reference to a specific version. To allow you to modify the Piston Assembly, you need to change it to a copy.

Manage Bins form

If the status of each item is not listed on the form, click the following button to display the status of each.

Status

Things to notice

Possible library status includes:

Co = copy
RfS = reference (specific version)
RfL = reference (latest version)

Piston Assembly

Modify Library Relationship form

Local copy

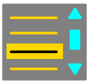
Things to notice

The “*Notify when original changes*” toggle that appears indicates that even though this assembly is a copy, you will be notified of any changes.

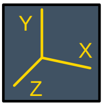
Change

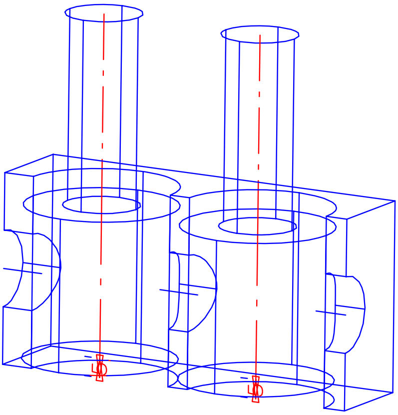
Get the Valve Assembly from the bin and onto the workbench.

Manage Bins form

 Valve Assembly

 *Dismiss*





Hint
If you don’t see the assembly, check the display filter.

Save your model file.

File
Save

Warning!
If you are prompted by I-DEAS to save your model file, respond:

No

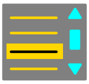
Save only when the tutorial instructions tell you—not when I-DEAS prompts you for a save.

If you make a mistake at any time between saves and can’t recover, you can reopen your model file to the last save and start over from that point.

Hint
To reopen your model file to the previous save, press Control-z.

In order to simplify the display in this tutorial you will delete one of the Piston Assemblies by using the *Delete* icon on the Hierarchy form.

Hierarchy form

 Piston Assembly

Hint

If you can’t see the assembly, move the Hierarchy form.

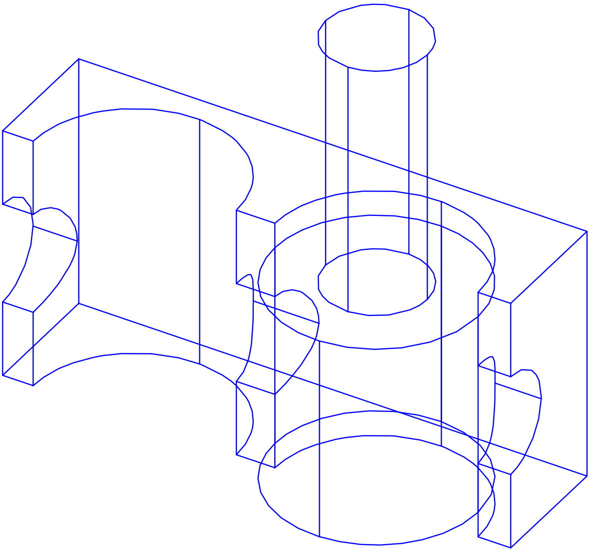
pick icon on form

I-DEAS Warning

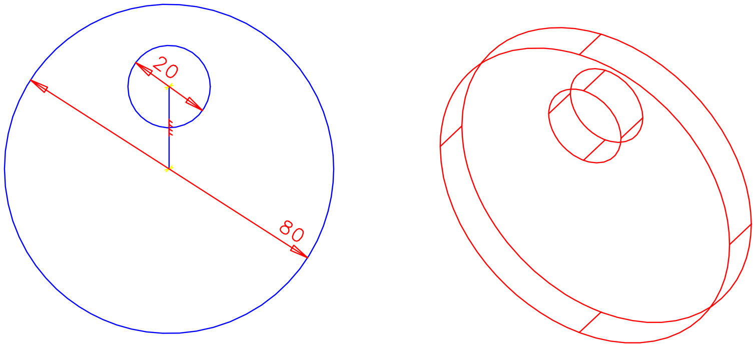
OK

Hierarchy form

Dismiss



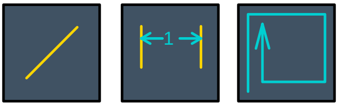
In the next few steps you will create a cam like the one shown below for the mechanism.

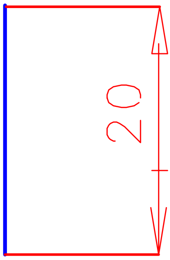


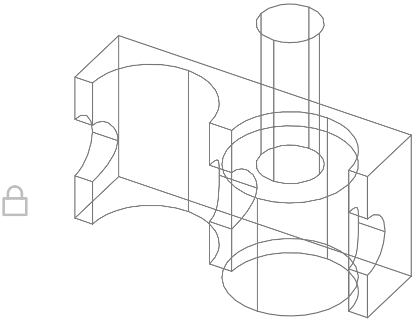
First, switch to the Modeling task.

 *Modeler*

Sketch a vertical line on the workplane and dimension it to 20mm.







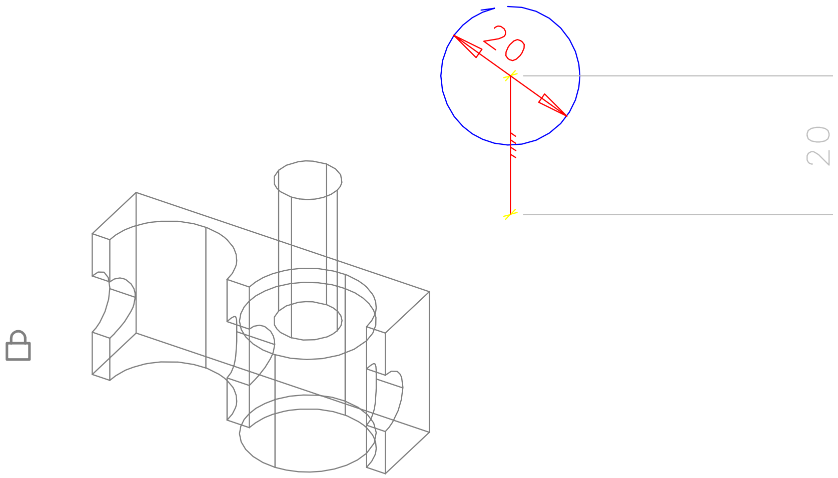
Create a circle with a radius of 10. Center the circle on the top of the vertical line.

Options...

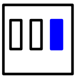
Circle by Center and Edge Options form

Radius: 10

OK



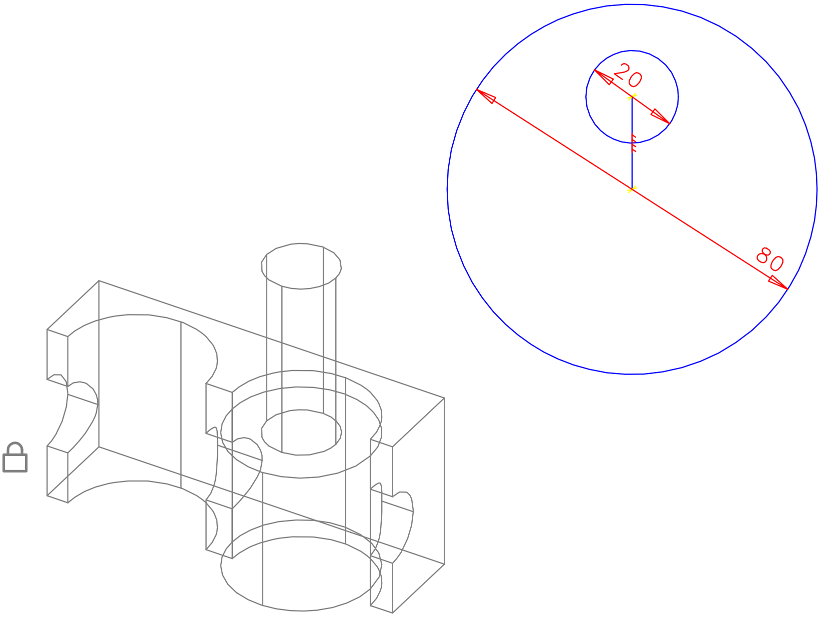
Create a circle with a radius of 40. Center the circle on the bottom of the vertical line.

 *Options...*

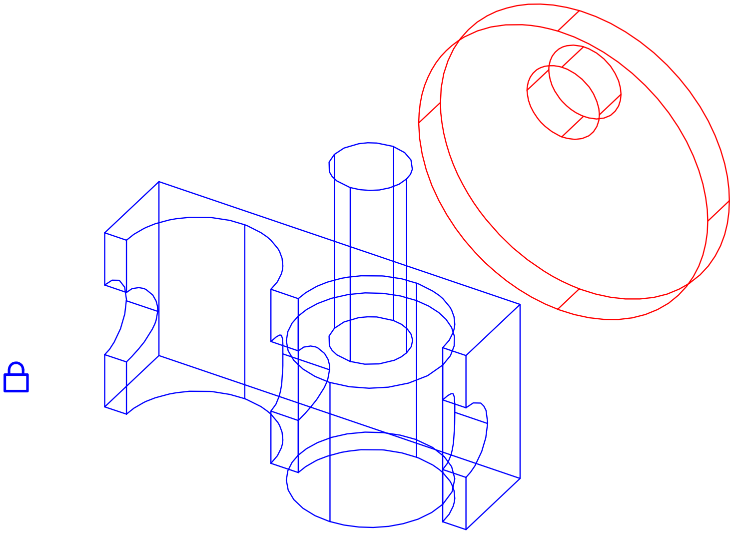
Circle by Center and Edge Options form

 *Radius:* 40

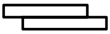
 *OK*



Extrude both of the circles to a distance of 10mm.



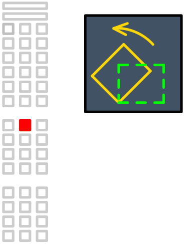
Recovery Point



File
Save

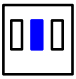
In the next few steps you will move the cam to align it with the Valve Assembly.

First, use *Rotate* to rotate the cam to the YZ plane.

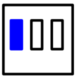


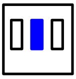
Check *I-DEAS Prompt*.

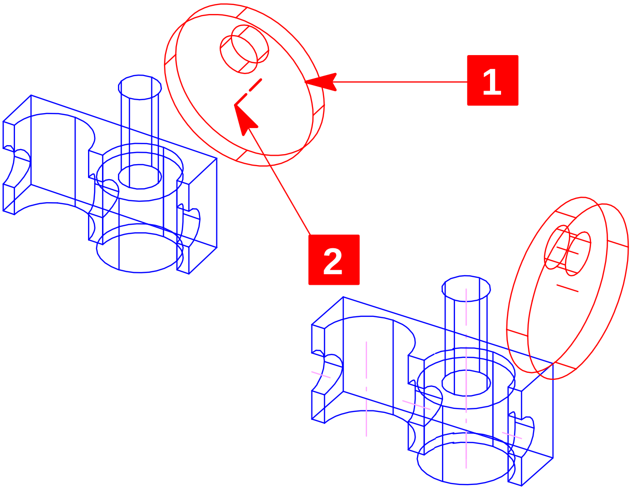
1 pick anywhere on the cam

 (Done)

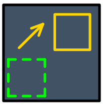
2 pick pivot point (centerpoint)

 *About Y*

 (90)



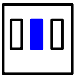
Next, move the cam so that the center point of the hole aligns with the top center of the pushrod.

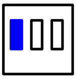


Remember

Watch the *I-DEAS Prompt* region.

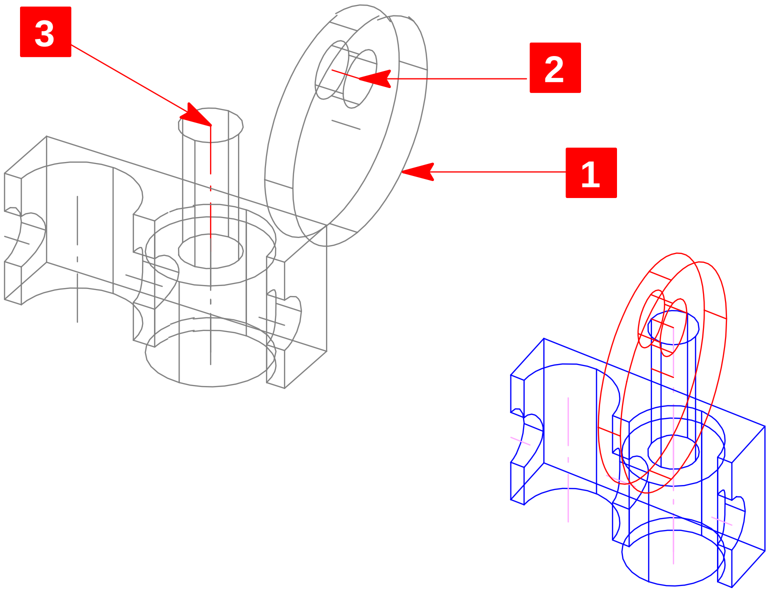
1 pick anywhere on cam

 (Done)

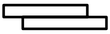
 *Move to*

2 pick center point of hole in cam

3 pick top center point of pushrod

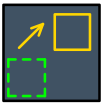


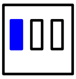
Recovery Point

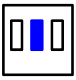
 *File*

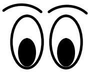
Save

Translate the cam 60mm in the Y direction to position it above the pushrod.

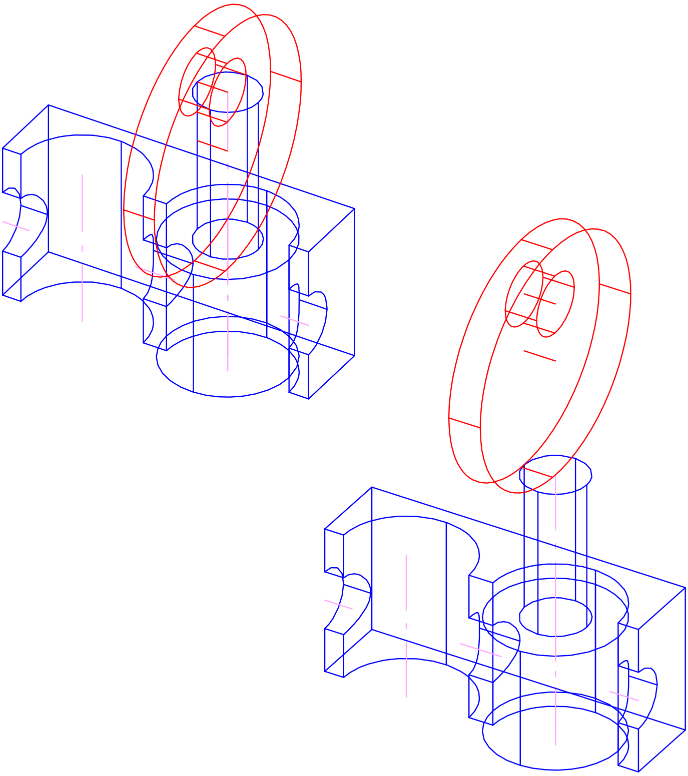


 pick anywhere on cam

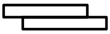
 (Done)

 **Check *I-DEAS Prompt*.**

 0 60 0 (type in and press Return)



Recovery Point

 *File*
Save

Switch tasks to *Mechanism Design.*

Modeler
Mechanism Design

Name the part “cam.”

Add the cam to the hierarchy.

Hierarchy form

Valve Assembly

pick anywhere on the cam

(Done)

Things to notice

The cam should now be listed on the Hierarchy form.

Dismiss

Deselect All

Recovery Point

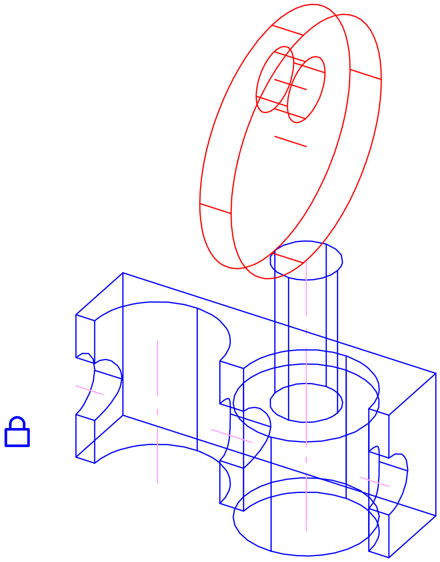
File
Save

A mechanism is an assembly with specific motions of parts (rigid bodies) constrained relative to positions of other parts. In the *Mechanism Design* task you can define a kinematic mechanism and calculate its motions and forces as a function of time.

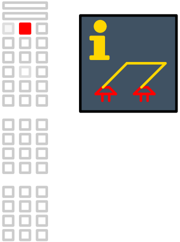
Rigid bodies are the mechanism and can be individual instances or subassemblies.

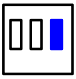
Joints, gears, and couplers control the motion between the rigid bodies (one joint controls the motion of one rigid body relative to another).

In this section you will define the piston assembly as a rigid body.



Select the *Information about Mechanisms* icon to list all the mechanism data.



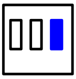
 *All Mechanism Data*

Check *I-DEAS List*.

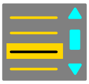
No mechanism data has been created yet. As you create mechanism data, by checking this list at each step, you can make sure you have done everything correctly.

Define rigid bodies

Use the Hierarchy form to rigidify the Piston Assembly.

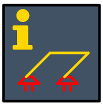
 *Hierarchy*

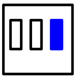
Hierarchy Selection form

 Piston Assembly

 *OK*

Select the *Information about Mechanisms* icon to list all the mechanism data.



 *All Mechanism Data*

Check *I-DEAS List*.
You should now see one rigid body listed for the Piston Assembly.

The Piston Assembly was defined as one rigid body, because both the piston and pushrod move as a unit. The joint creation commands automatically make single part instances into rigid bodies for you.

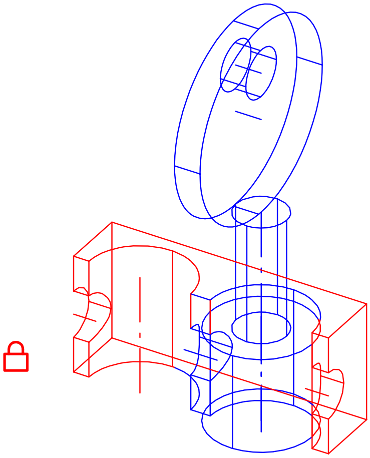
If the rigid body was defined properly, save your model file.

Recovery Point

File
Save

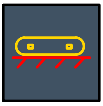
Each link in the mechanism is called a “rigid body.” A rigid body can be any instance within the assembly. If a subassembly is selected as a rigid body, all children of that subassembly will move as a unit.

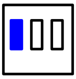
The internal solver requires that at least one rigid body be grounded. This restriction may not apply to all external solvers, but many solvers will require it.

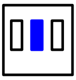


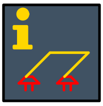
Ground rigid bodies

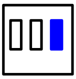
Ground the valveblock so it will not move.

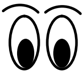


 pick anywhere on the valveblock

 (Accept)

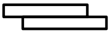


 *All Mechanism Data*



Check *I-DEAS List*.
The valveblock is now listed as a selected ground. The total number of grounds is one, the total number of rigid bodies is two. Grounding an instance also makes it a rigid body if it wasn't previously. To be solved, a mechanism must have at least one ground.

Recovery Point

 *File*
Save

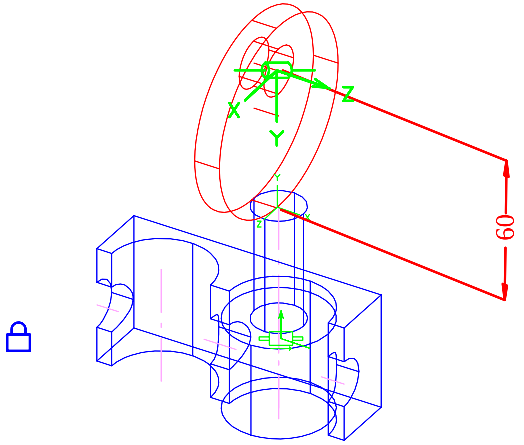
A joint allows one or more degrees of freedom of motion while restraining others. Each freedom of motion has an associated joint variable. Joint variables can either be left free to move, or they can be defined by a function which will drive the mechanism. The joint variables can be plotted after solving for the motion of the mechanism.

A joint connects two markers (reference triads) on different rigid bodies. A marker is placed on a rigid body to define the location and orientation of joints and loads. The definition of a marker contains its location and orientation of joints and loads. Unless you are creating a mechanism that requires gears or complex constraints, you may never have to explicitly define markers; because when you use one of the I-DEAS joint commands, it will automatically create the required marker for you.

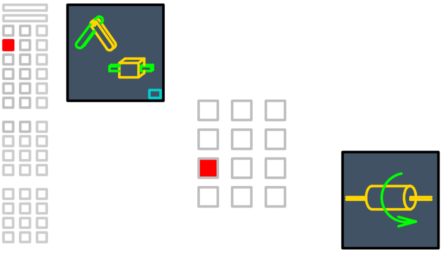
Typical types of joints are pins (revolute joints), sliders (translational joints), or cam followers, all of which define the degrees of freedom between the connected rigid bodies.

In this section you will add to the assembly:

- a cylindrical joint allowing translation and rotation about one axis
- a translational joint allowing translation along one axis
- a cam follower which converts rotation of one rigid body to the translation of another



Add a cylindrical joint to the mechanism.

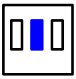


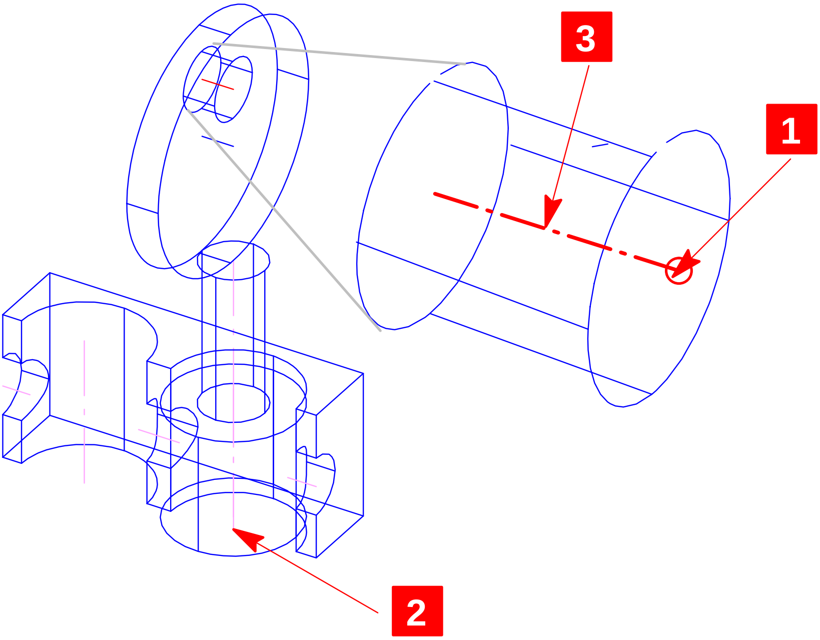
1 pick the cam hole center point

2 pick the valveblock hole center point

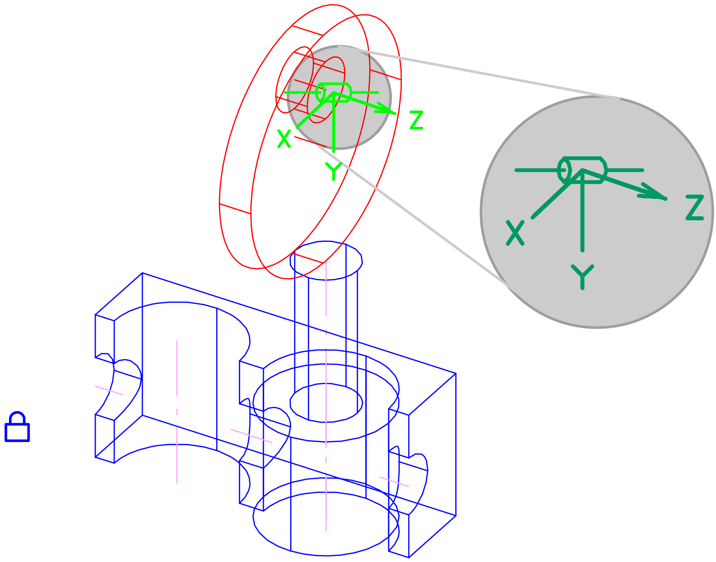
Hint If there are coincident entities in the pick area, I-DEAS lists the coincident entities by their complete label, which includes instance name and entity name. Select the correct entity from the list. This mechanism has several places where you must pick by label.
If you prefer to pick from the screen without additional prompts, pick *Options, Preferences, Selector* and adjust the pick radius value lower.

3 pick center line in cam (for z axis)

 *Yes*

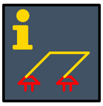


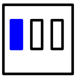
Result



Hint Don't close the *Constraints* subpanel.

Check that the cylindrical joint has been created correctly.



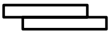
 pick the joint graphic

Things to notice

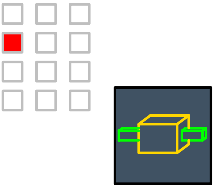
A cylindrical joint has been created with a joint variable, now defined as zero degrees. It should be connecting between the cam and the valveblock.

If everything is correct, save your model file.

Recovery Point

 *File*
Save

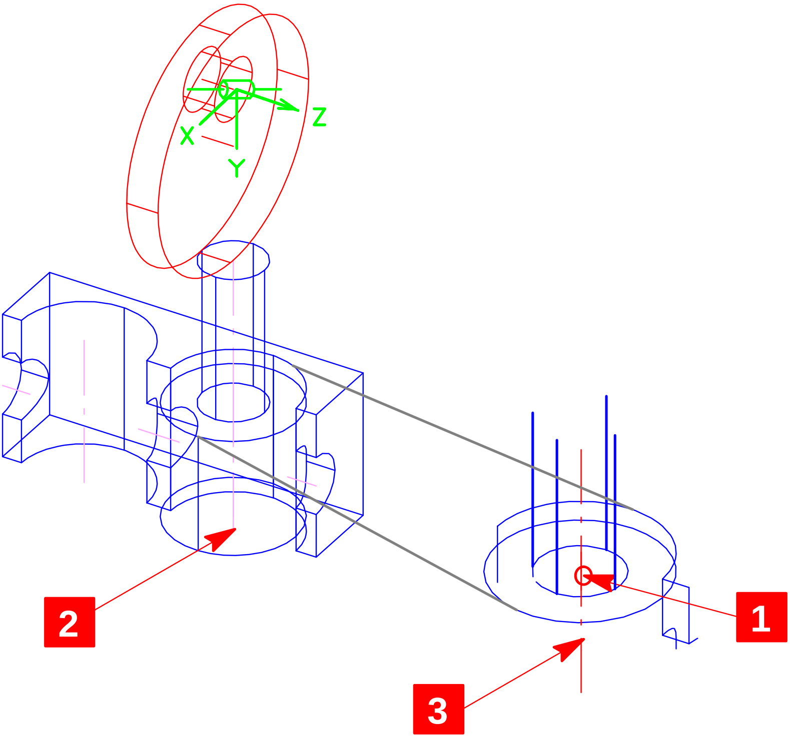
Add a translational joint between the piston and the valveblock.

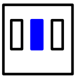


1 pick center point at top of piston (to pick joint origin)

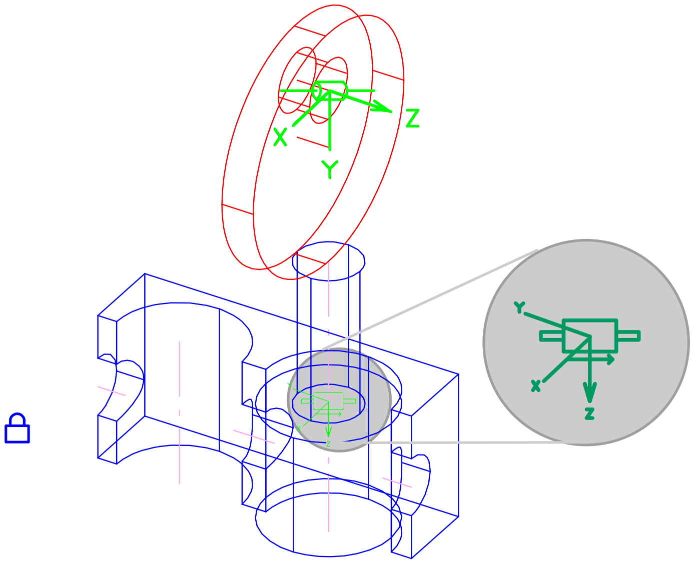
2 pick valveblock center point

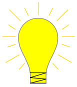
3 pick center line in piston (for z axis)



 *Yes*

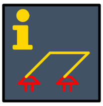
Result

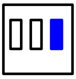




The graphical symbol showing the joint is not an exact representation of the joint. It is only a symbol showing the type and location of the joint.

Check that the translational joint has been created correctly.



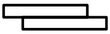
 *All Mechanism Data*

Things to notice

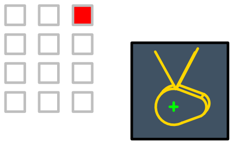
There should be a translational joint with a joint variable of 0mm. It should connect between the valveblock and Piston Assembly instances. There are now three rigid bodies. I-DEAS made the cam instance a rigid body when you created the cylindrical joint.

If everything is correct, save your model file.

Recovery Point

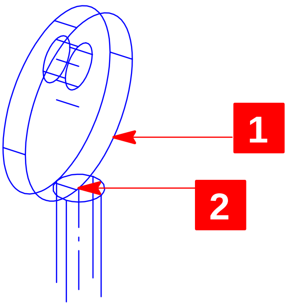
 *File*
Save

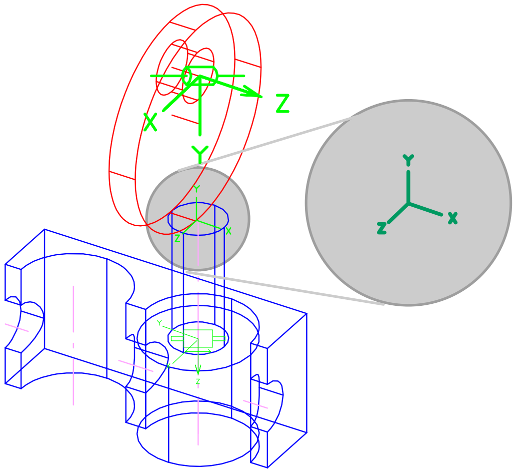
Create the cam follower joint.

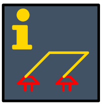


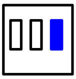
1 pick edge of cam

2 pick center point of pushrod







 *All Mechanism Data*

Close the *Constraints* panel.

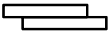
Check *I-DEAS List*.
Scroll back to find the cam follower joint connecting the cam and Piston Assembly.

If everything is correct, save your model file.

Recovery Point

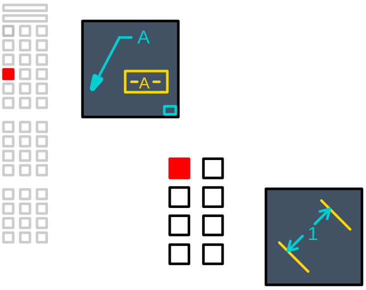
File
Save

Switch to the Assembly task.



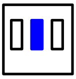
Mechanism Design
Assembly

Add an Assembly Annotation Dimension to the mechanism. The dimension does not control the distance, but will display the distance as the mechanism is animated.



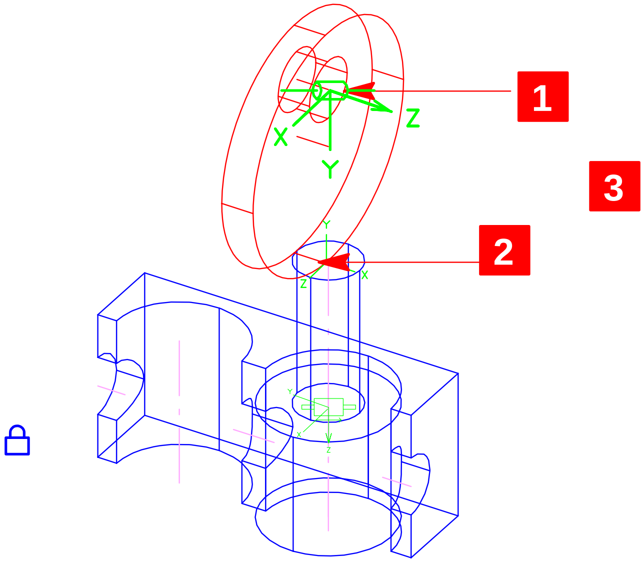
1 pick center point of hole

2 pick center point on top of pushrod



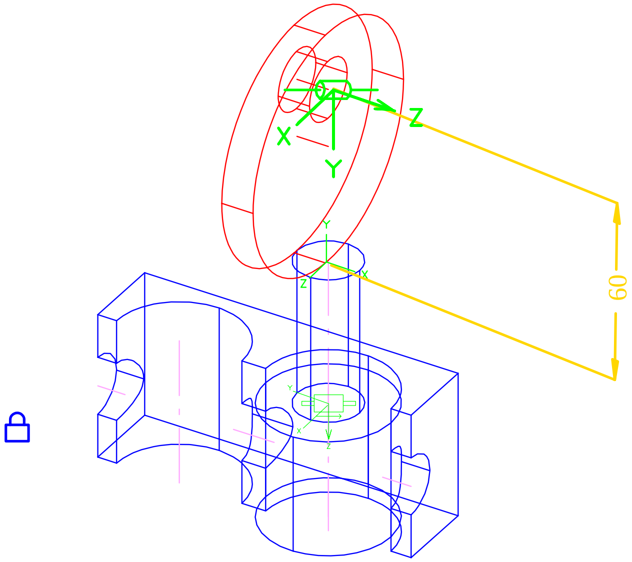
Default

3 locate text

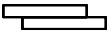


Close the Annotate panel.

Result



Recovery Point

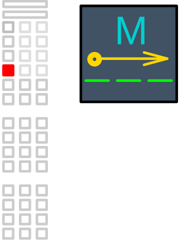

File
Save

Mechanisms can be defined and solved within the *Mechanism Design* task or solved with an external solver such as ADAMS. The Mechanism Design task doesn't create forces or solve for them. Solving for forces requires a separate license for Mechanism Simulation. In this case, we will create a motion to drive the joint variable on the cylindrical joint as a function of time.

Switch to the *Mechanism Design* task.

Assembly
Mechanism Design

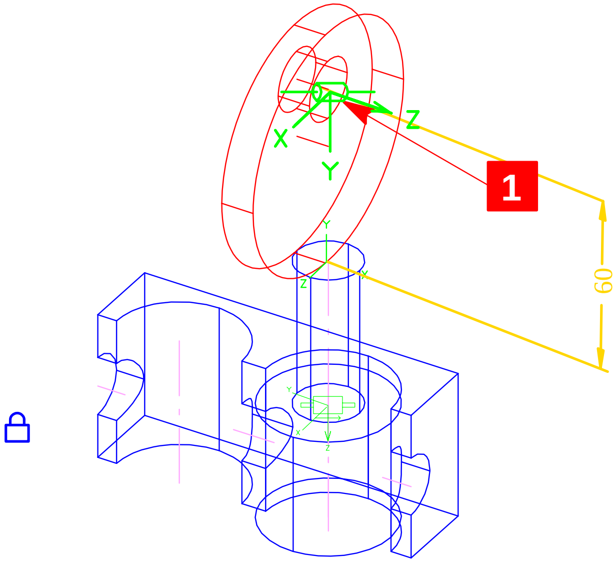
Create a motion to drive the cylindrical joint.



Check *I-DEAS Prompt*.

Cam Rotation

1 pick the cylindrical joint



Rotational

Constant Velocity

(1 rev/sec)

Check *I-DEAS List*.
Find the Cam Rotation motion defined for the cylindrical joint.

If everything is correct, save your model file.

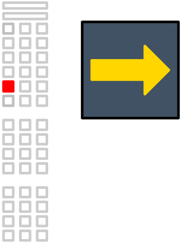
Recovery Point

File
Save

Solve Setup

In this section you'll define the loads, solve parameters, and output selections to use when you *Solve* the mechanism.

Use Solve to setup the run parameters.



Solve Setup form

Describe the run.

Description: valve motion

Define the applied loads.

All Loads

All Loads is the default. Notice that you could pick a pre-defined loadcase or select individual loads instead.

Define the solution parameters.

Steps: 50

If you are using a slow graphical display, you may want to use fewer steps to get faster animation. However, with too large a change between steps, the software may not find the correct solution from one step to the next.

Specify results.

Output selection

Mechanism Output Selection form

- *Body Displacement*
- *User Requests*
- *OK*

Solve Setup form

Don’t exit this form yet.

Solve

If everything is defined for the mechanism, the next step is to solve for the motion of the mechanism. In this case we will use the internal solver.

A sequence will also be created of all these new configurations, which you can then animate. Other functions of joint variables and marker positions will be stored.

If the solve aborts due to a file not found message, try opening the permissions on the directory you are using.

To improve efficiency for complex mechanisms: turn on *Animate while solving.* Turn off *Create Functions* and *Create Sequence* until you reach the desired solution. This improves performance significantly, reduces the model file size, and you won’t have to delete unwanted sequences.

Solve the mechanism.

Solve Setup form

 *OK*

When you pick *OK*, the solve is immediately initiated. Information is displayed during the solve in the *I-DEAS List Region*.

Things to notice

The I-DEAS list region has the following information:

- selected loads
- degrees of freedom
- redundant constraints
- solve type
- the end time and number of output steps
- processing results
- the name of the sequence and the amount of configurations created

There are zero redundant constraints because you created this mechanism with a cylindrical joint between the cam and valveblock. Using a revolute joint instead would create one redundant translational constraint. Both the cam–valveblock revolute joint and the piston–valveblock translational joint constrain translation in the global x direction.

Mechanism constraints are different from the constraints applied in the Assembly task. Assembly constraints are ignored when the mechanism is solved.

After the solution is completed, configurations and a sequence containing all of the configurations will be stored. (If it does not exist, this indicates that the selection must have aborted due to an error in defining the mechanism.)

Warning! Do not toggle *Ignore Constraints* off. Otherwise, the assembly dimension constraint (which was ignored during the mechanism solve) will cause the piston assembly to snap back to the original position.

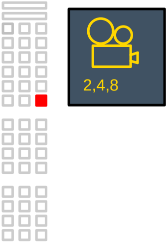
In this section you will animate the sequence.

Things to notice

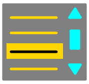
As you look at the animation closely, you'll see that the approximation of using a cam-follower joint is not quite accurate. To make a more accurate model, you could use a cam-cam joint, or create a pointed top to the pushrod.

Animate the mechanism.

To clarify the animation, you may want to turn off *Mechanism marker* and *Joints* under the Assembly button on the Display Filters form.



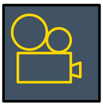
Animate Hardware form

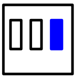
 Run1

 *Dismiss*

If the *Animate Hardware* icon is not supported, you'll have to use the *Animate Software* icon to animate your sequence. If you do, use the right mouse button menu to end the animation and to vary the speed.

Hint



 *End*

Tutorial wrap-up

You have completed the Creating a Mechanism tutorial. Before exiting, delete the assemblies, and parts used in this tutorial.

Manage Bins form

Valve Assembly

Delete form

Recursively Delete Related Parts and Sub-Assemblies

Delete

I–DEAS Warning form

OK

Do not delete the bins.

Manage Bins form

Dismiss